B Production

in recent MC models

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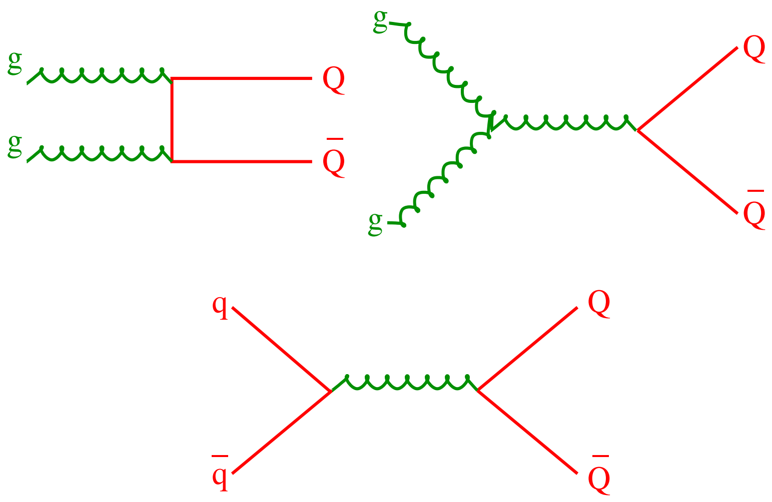
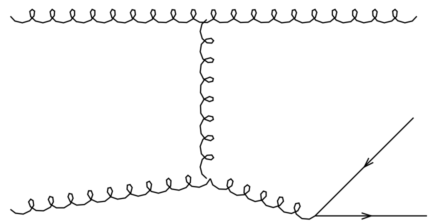
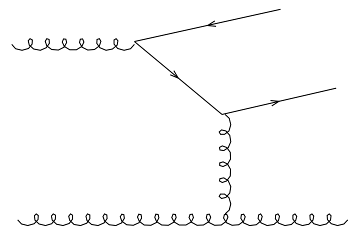
Heavy Quark Production in $p\bar{p}$



LO Heavy Quark Production



NLO: Gluon splitting



NLO: Flavour excitation

$$\underbrace{\frac{d\sigma(p\bar{p}\rightarrow BX)}{dp_T(B)}}_{expected} = \underbrace{f^{p,\bar{p}}}_{\text{Proton structure}} \otimes \underbrace{\frac{d\sigma(qq/gg/qg\rightarrow bX)}{dp_T(b)}}_{\text{NLO/NNLO QCD}} \otimes \underbrace{D^{b\rightarrow B}}_{\text{fragmentation}}$$

NEW: MC@NLO

- Merging of NLO QCD with the HERWIG parton shower
- Shower corrections are large and strongly modify the shape of the spectrum

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Matching NLO QCD and Parton Showers in Heavy Flavour Production*

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Abstract: We apply the MC@NLO approach to the process of heavy flavour hadroproduction. MC@NLO is a method for matching next-to-leading order (NLO) QCD calculations and parton shower Monte Carlo (MC) simulations, with the following features: fully exclusive events are generated, with hadronisation according to the MC model; total rates are accurate to NLO; NLO results for distributions are recovered upon expansion in α_s; hard emissions are treated as in NLO computations while soft/collinear emissions are handled by the MC simulation, with the same logarithmic accuracy as the MC; matching between the hard and soft regions is smooth, and no intermediate integration steps are necessary. The method was applied previously to the hadroproduction of gauge boson pairs, which at NLO involves only initial-state QCD radiation and a unique colour structure. In heavy flavour production, it is necessary to include contributions from final-state QCD radiation and different colour flows. We present illustrative results on top and bottom production at the Tevatron and LHC.

Keywords: QCD, Monte Carlo, NLO Computations, Resummation, Collider Physics, Heavy Quarks.

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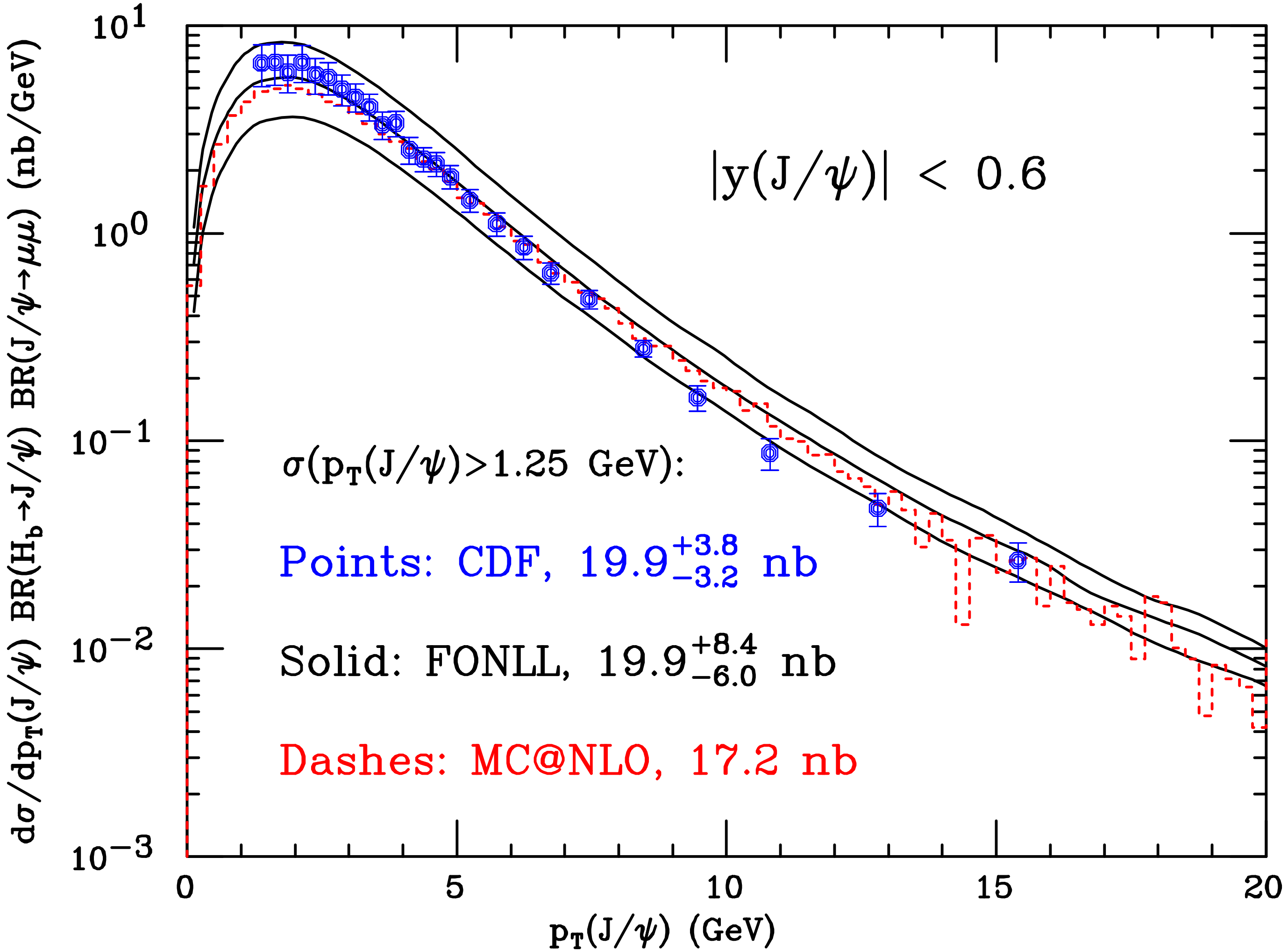
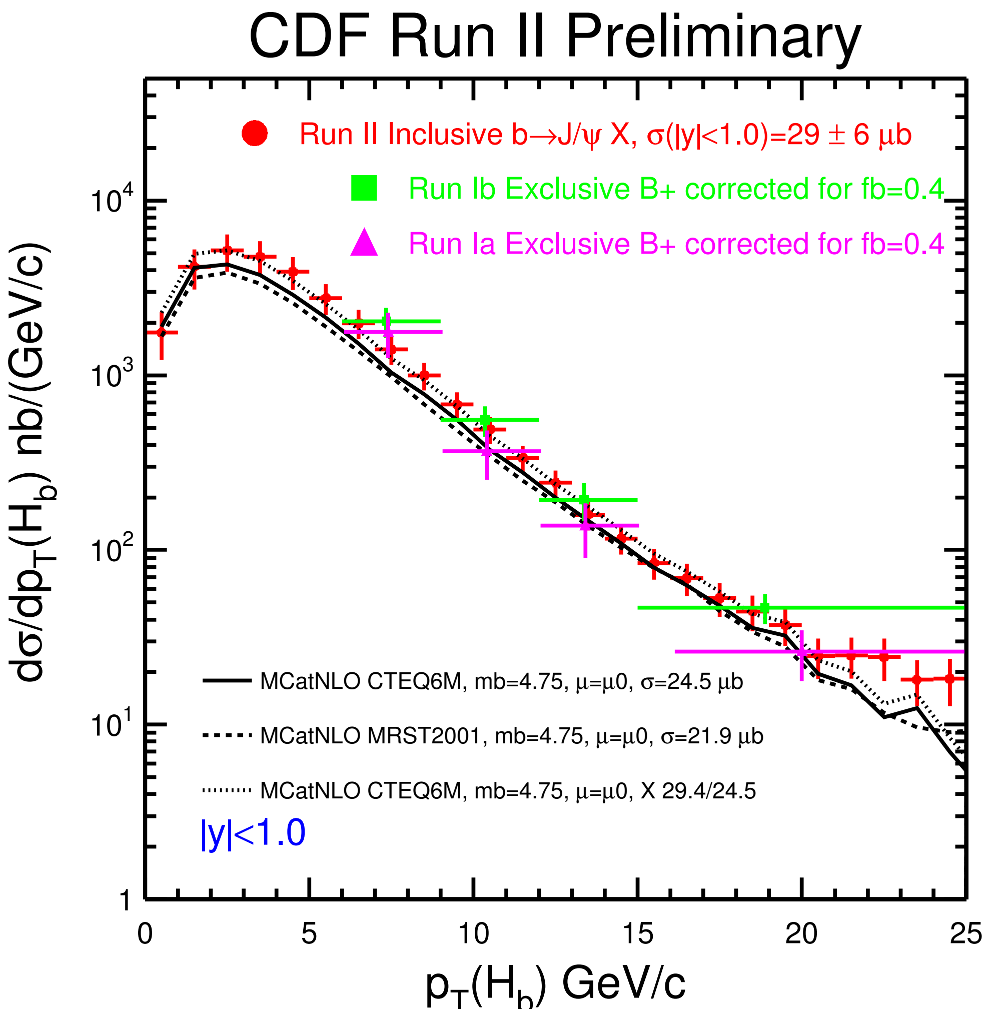
MC@NLO comparison with data

CDF measured the crossection of $p\bar{p} \to H_b X,\ H_b \to J/\psi X$



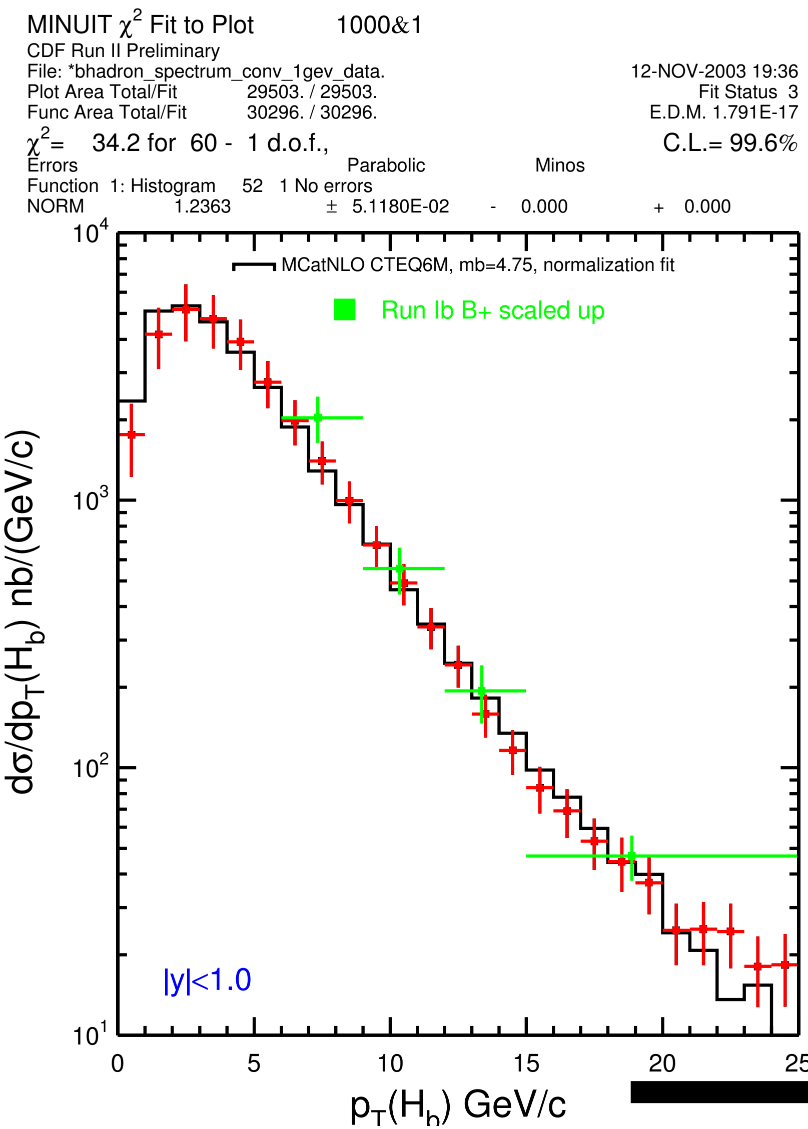
MC@NLO comparison with data

- We deconvoluted the J/ψ spectrum and obtained the H_b production spectrum.
- MC@NLO with CTEQ6M PDF matches data best at low and mid p_T
- Normalization is 20% lower than data (~ 1 σ)



Fit normalization

- Allow normalization to float and pick best fit to Run II
- Hmmm... Seems OK. Even with Run Ib B+.



Measured Fragmentation Function

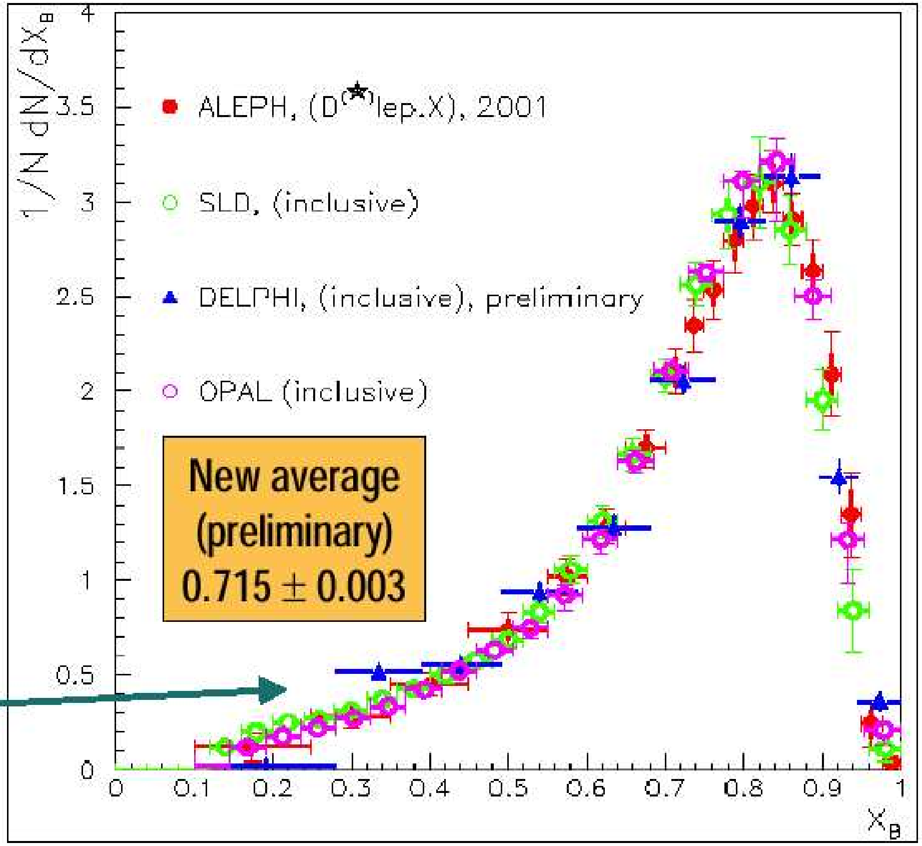
- Recent results from ALEPH (May 2001), SLD (May 2002), OPAL (October 2002, not published) and DELPHI (not published).
- Average < 1995 (still used): 0.702±0.008
- Mean values:
  - ALEPH: 0.716 ±0.006 ±0.006
  - DELPHI: 0.7153±0.0007±0.0051
  - OPAL: 0.7193±0.0016±0.0034
  - SLD: 0.709 ±0.003 ±0.003 ±0.002(model)

Definition:

$$x = \frac{E_B}{E_{beam}} \qquad D(x) \equiv \frac{1}{\sigma_{tot}} \frac{d\sigma}{dx}$$

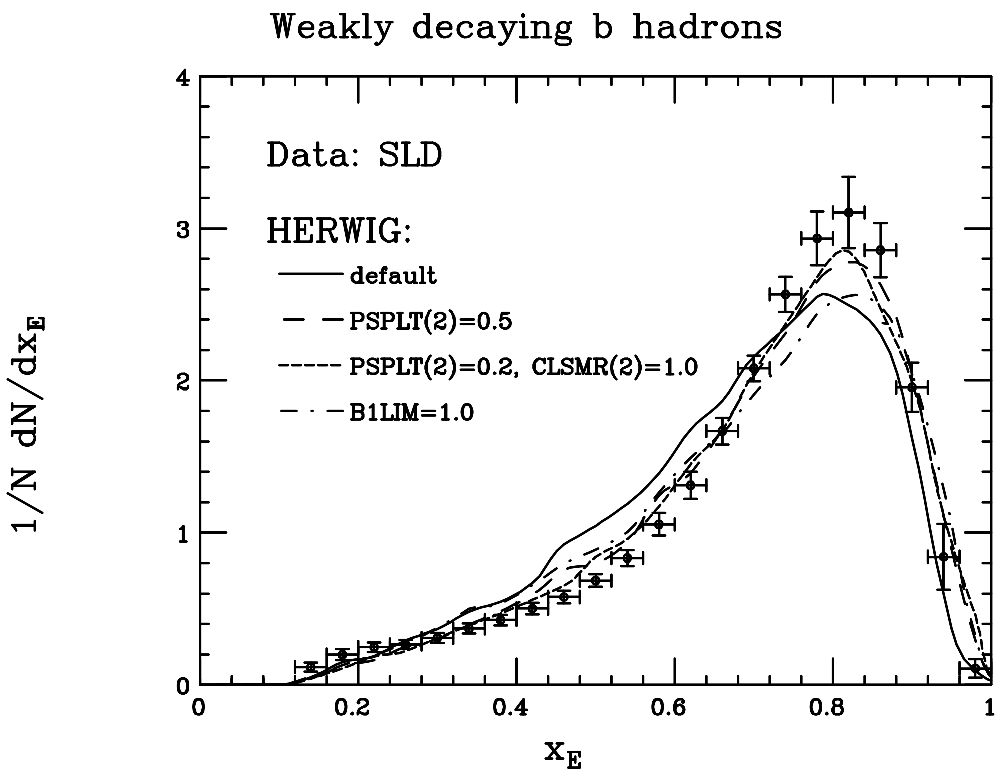
Systematics dominate

Bin contents are correlated



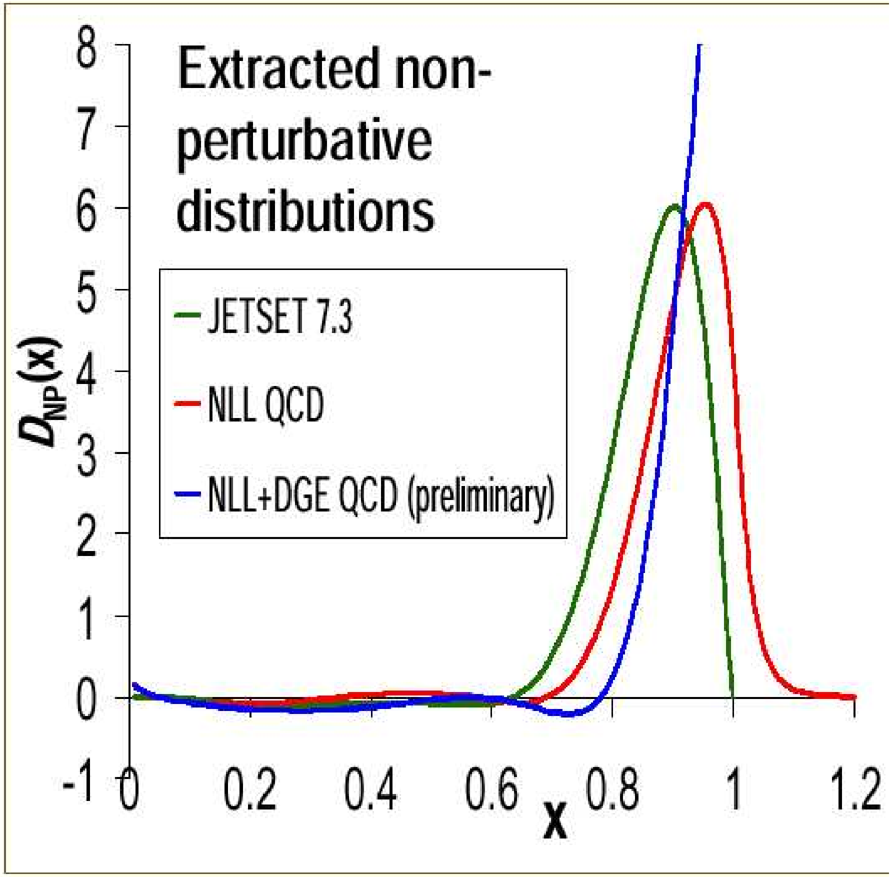
HERWIG B-fragmentation

- BUT: HERWIG does not fit b-fragmentation well



Extract non-perturbative

- Extraction point by point.
- 3 perturbative Approches:
  - Monte Carlo (JETSET 7.3).
  - NLL QCD, *Cacciari and Catani.*
  - NLL+DGE QCD, *Cacciari and Gardi, hep-ph/0301047.*
- non-perturbative = F (perturbative)
- Low x region indicates gluon radiation is well accounted in the perturbative components.
- Higher order QCD → the non perturbative part starts at larger x.
- The non-perturbative functions for JETSET and NLL QCD have similar shapes, translated.



This Non perturbative functions are expected to be valid in a different environment than e^+e^-, only in the framework where similar perturbative assumptions are used for its extraction.

Conclusions

- MC@NLO produces a shape that is in reasonable agreement with data
- BUT HERWIG doesnt do the best job of modeling b-fragmentation
- Use MC@NLO b-hadron x-section shapes for current MC
- Tune Pythia with the correct non-perturbative fragmentation distributions and recompare to data (Eli).